BIOLOGY OF PLANTS

FOURTH EDITION

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Table 18–1 *Main Differences between Monocots and Dicots*

CHARACTERISTIC	DICOTS	MONOCOTS
Flower parts	In fours or fives (usually)	In threes (usually)
Pollen	Basically tricolpate (having three furrows or pores)	Basically monocolpate (having one furrow or pore)
Cotyledons	Two	One
Leaf venation	Usually netlike	Usually parallel
Primary vascular bundles in stem	In a ring	Complex arrangement
True secondary growth, with vascular cambium	Commonly present	Absent

18–36
The giant eucalyptus, or red tingle (Eucalyptus jacksonii), *growing in the Valley of the Giants in southwestern Australia. The enormous stature of this angiosperm is evident by comparison to the man standing in its burnt-out base.*

(a)

(c)

(b)

18–37
The duckweeds (family Lemnaceae) are the smallest flowering plants; their structural features mark them as extremely reduced derivatives of the aroid family (Araceae), the family that includes calla lilies (Zantedeschia) *and* Philodendron. (a) *A honeybee resting on a dense floating mat of three species of duckweed. The larger plants are* Lemna gibba, *about 2 to 3 millimeters long; the smaller ones are two species of* Wolffia, *up to 1 millimeter long.* (b) *A flowering plant of* Wolffia borealis, *with a circular concave stigma (looking like a tiny doughnut) and a minute anther just above it, both protruding from a central cavity. The whole plant is less than 1 millimeter long.* (c) *Flowering plant of* Lemna gibba; *two stamens and a style protrude from a pocket on the upper surface of the plant.*

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PLANTS

AN INTRODUCTION TO MODERN BOTANY

Victor A. Greulach & J. Edison Adams

PROFESSORS OF BOTANY, UNIVERSITY OF NORTH CAROLINA

Captions and credits for special photographs are as follows:

SECTION I. Some of the big trees in a California redwood grove. *Courtesy of Moulin Studios, San Francisco.*

SECTION II. Electron micrograph of cells of a corn leaf showing two chloroplasts and other cell organelles. *Courtesy of Dr. Howard J. Arnott, Cell Research Institute, University of Texas, Austin.*

SECTION III. Studying the influence of growth substances on isolated plant roots. *Courtesy of Dr. James Bonner, California Institute of Technology.*

SECTION IV. Synchronized meiosis in pollen parent cells of *Trillium*. *Courtesy of Arnold H. Sparrow, Brookhaven National Laboratory.*

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Prefac

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Photograph courtesy of U.S.

line with a fossil record going back to the Permian period. A native of China, *Ginkgo* is widely planted as an ornamental tree in parks and along city streets where it seems quite tolerant of the noxious dirt and fumes of modern city traffic. Only the male trees are usually planted, because the ripe pulpy seeds of the female trees emit a disagreeable odor.

The Angiospermae or flowering plants are the most numerous and the most important of all the plant groups, numbering more than 200,000 species. The herbs, grasses, shrubs, and broad-leaf trees from which most of our foodstuffs and many industrial materials come are flowering plants. A distinctive structural feature is the **flower** (Figs. 5.38, 5.43) which consists essentially of a condensed or shortened stem bearing whorls or spirals of modified leaves, and in which the seeds are produced within a closed case-like structure, the **ovulary** (Chapter 5). The name angiosperm (*angeion*, enclosing vessel; *sperma*, seed) in fact, points up one of the important contrasts with the gymnosperms. The ovulary develops into a true fruit, a structure characteristic of the angiosperms. There are other distinctive features that are better discussed in another context. These will be shown in later chapters. Compared with the other groups of plants, the angiosperms are considered from fossil evidence to be of relatively recent origin, the oldest authentic representatives occurring in the late Mesozoic era (Table 18.1). No fossil evidence is available that clearly suggests the pathways by which they may have originated from older groups of vascular plants.

For the angiosperms in particular, it is desirable to carry the classification one step further at this point by mentioning the two recognized **subclasses**, Monocotyledoneae and Dicotyledoneae. Many other classes throughout the Plant Kingdom are similarly divided into subclasses by the taxonomists, but these are of special prominence in our modern angiospermous flora. The Monocotyledoneae, often referred to cryptically as "monocots" include such familiar plants as orchids, irises, lilies, grasses, sedges, and palms. Typically, the embryo within the seed of these plants possesses *one* well developed **cotyledon** or seed-leaf (Fig. 5.50*b*). With notable exceptions, the leaves are narrow, the veins running parallel from base to apex. In most of them the vascular tissue of the stem is relatively scanty and the stem is incapable of massive diametric growth with the formation of additional vascular tissues (Fig. 5.14). In contrast, Dicotyledoneae or "dicots" possess *two* cotyledons (Fig. 5.50*a*, *c*). The leaves, except in many small herbs, are typically broad and the leaf veins are usually arranged in rib-like or net-like patterns (Fig. 5.23). The vascular tissues of the stem are typically arranged in a circular pattern, and many of them are capable of producing considerable additional vascular tissue through the action of lateral meristems (Fig. 5.5). Broad-leaf

trees such as ash, maple, and oak; shrubs and vines such as rose, poison ivy, and lilac; and herbs such as mustard, tomato, and chickweed are representative of the Dicotyledoneae.

SMALLER CATEGORIES OF CLASSIFICATION

Although it is important to view the plant kingdom in its largest aspects as we have done, and to summarize it in some all-embracing scheme of classification, it is true that the common plants growing around us are thought of in terms somewhat less inclusive than division or class. Just as we have seen that the plant kingdom may be subdivided into divisions, and the divisions into classes, so botanists recognize the need for progressively smaller and smaller categories. This need becomes obvious when, on an afternoon's stroll, we encounter, for example, six different kinds of oaks, three kinds of maples, and three kinds of pines.

Quite naturally, we give names to the things we know and use; so we apply names to the plants around us. First, these names are likely to be chosen with reference to some quality or attribute of the plant. A descriptive name, an allusion to a use, or a fanciful reference may, and often does, suffice as a common name. Thus "Blood Root," to describe the red sap exuding from the plant when cut, and "Mayflower," to describe the time of flowering, are well-chosen common names for the respective plants. But the same plants may be known by different and equally good names in other localities, or indeed, the same names may be applied to altogether different plants. There are said to be eighteen different species or kinds of plants growing in the United States that pass under the name "Snakeroot." It is clear that confusion would be unending if there were not some standard system of naming. The scientific study of plants requires a precise identification of the plants. To this end, in botanical practice, one valid name is given to each plant species, and it bears that name throughout the world, wherever scientific study of plants is pursued. The names given are in Latin or are occasionally derived from Greek. Botanists, regardless of nationality, can understand precisely what plant is indicated by its scientific name.

The scientific name of a plant consists of two parts, the name of the genus followed by the specific epithet. Thus the sugar maple is named *Acer saccharum*. To insure greater accuracy in the designation of plant species, the identity of the author of the plant's valid scientific name is appended, usually as an abbreviation: e.g., *Acer saccharum* Marsh. (for Humphrey Marshall, the botanist who first described and named this species of maple). A species is a single *kind* of plant in which all the individual members are similar in most of the

The Times

y's Field, Rydal.
:s named after the poet's sister.

INTERMEDIATE BOTANY

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CHAPTER XXX

CLASSIFICATION OF ANGIOSPERMS

Throughout the ages, different bases have been chosen for plant classification ; but to-day we use the most natural of them all, that is, according to evolutionary sequence so far as that can be recognised. During evolution, living organisms have undergone progressive changes, mainly involving an increase in efficiency and complexity, though at times one comes across examples of degeneration and degradation. So it does not always follow that the more simple a plant organism is, therefore the lower it is in the scale of evolution ; but it is usually so.

In a classification which is based on evolutionary sequence and change the more variable characteristics are the most valuable as clues. The root, for example, is practically useless, for it is subject to the least changeable of all environments and has, therefore, suffered little change throughout the ages. Foliage leaves, too, are not sufficiently diagnostic as a basis for plant classification, though sometimes they are useful for making specific distinctions. In fact, the most changeable organ of the plant is the flower, so it is on this structure mainly, though not entirely, that flowering-plant classification is based.

The classification of plants (and animals) to-day follows fairly closely that made by the Swedish biologist Carl von Linné (usually known as Linnaeus). His whole scheme for the classification of plants was set out in his *Species Plantarum* published during 1753, though he had actually announced his system in *Systema Naturae* in 1735. But, of course, many thousands of different plants have been discovered since the days of Linnaeus, and botanical research has also revealed much more about them, so that though present-day classification does follow the technique devised by Linnaeus, it has become much modified.

Angiosperms may first of all be divided into two great groups—the Monocotyledons and the Dicotyledons.

The Dicotyledons form the larger group. They are characterised by the presence of two cotyledons or seed-leaves in their embryos. Their foliage leaves are usually narrow at the base, and may be stalked or sessile. Most of them are net-veined. The stems and roots of many become secondarily thickened. The flowers are sometimes composed of whorls with an indefinite number of segments, though most dicotyledonous flowers have either five, or a multiple of five, or four, or a multiple of four, members to each whorl. Dicotyledons are either annual, biennial, ephemeral or perennial, the last-named often taking the form of shrubs or trees. In some Dicotyledons the petals are free, whereas in others they are joined. Those having free petals are looked upon as being lower in the scale of evolution.

The Monocotyledons comprise those families of Angiosperms characterised by the presence of only one cotyledon in the embryo. Their leaves are usually (but not always) parallel-veined with almost entire (smooth) margins, whereas the leaves of Dicotyledons are net-veined and frequently serrated, lobed or compound. In Monocotyledons the number of parts of the flower is usually three or multiples

of three. The internal anatomy, especially of stems and roots, also differs from that of Dicotyledons. For example, in very few Monocotyledons is there any mechanism for secondary thickening, so there are few monocotyledonous trees or shrubs.

PLANT NOMENCLATURE

Every type of plant is a species. For example, among the buttercups or crowfoots, there are several types, such as creeping buttercup, bulbous buttercup, water crowfoot, and so forth. Each is a separate **species**. Creeping buttercups belong to one species, but bulbous buttercups belong to a different species from that of the creeping. So there are different species of buttercups, but they are all closely related to each other so they are grouped together in what is called a **genus**. Therefore different buttercups belong to the same genus but different species.

In order to make the necessary distinction in nomenclature, Linnaeus suggested each plant having two names, one to designate the genus, the other the species. This is the **binomial system** adopted to-day for all plants. For example, all buttercups belong to the genus *Ranunculus*. This is the generic name. Then each species is assigned a second or specific name. Thus the botanical name for the water crowfoot is *Ranunculus aquatilis*; that for the bulbous buttercup is *Ranunculus bulbosus*; creeping buttercup, *Ranunculus repens*; the lesser celandine, *Ranunculus ficaria*, and so on for the rest of the genus. The generic name is usually chosen to indicate some character of the whole genus, and the specific name to indicate an outstanding character of the species. Sometimes the names are chosen to celebrate the name of some well-known botanist, and sometimes the names are chosen for other reasons.

Just as species differ from each other, though some resemble each other sufficiently to be grouped under the same genus, so do genera themselves differ from or resemble each other. For example, closely related to the buttercup is the paeony. Thus, though the paeony is sufficiently different from the members of the genus *Ranunculus* to warrant another genus (*Paeonia*), the two genera resemble each other closely and are kept together in classification. Other genera also resembling these two are the following (in brackets after each genus is the common name of one plant belonging to it): *Caltha* (marsh marigold), *Nigella* (love-in-a-mist), *Aquilegia* (columbine), *Delphinium* (larkspur), *Aconitum* (monk's hood), *Clematis* (clematis or traveller's joy), *Thalictrum* (meadow rue), *Anemone* (wood anemone), *Adonis* (pheasant's eye), *Myosurus* (mouse-tail), *Trollius* (globe flower), *Helleborus* (hellebore), *Eranthis* (water aconite), *Actaea* (baneberry). All these genera are so closely related to each other that they are placed in a still bigger group called a **family**. In this cases the family is called RANUNCULACEAE. Examples of this family are given in the table on p. 437.

The classification is carried still further in that many families are closely related to each other. Those so related are grouped into what is called a **cohort** or **order**. For example, other families closely related to RANUNCULACEÆ are NYMPHÆACEÆ, to which the white water-lily (*Nymphæa alba*) and the yellow water-lily (*Nuphar luteum*) belong; CERATOPHYLLACEÆ, to which the hornwort (*Ceratophyllum submersum*) belongs; and BERBERIDACEÆ, to which the barberry (*Berberis vulgaris*) and other genera belong. Thus all these families, together with Ranunculaceæ, are grouped in the order **Ranales**.

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